

Lawrence Livermore National Laboratory

Preliminary Report: Improving Used Oil Recycling in California

Presentation to the California Integrated Waste Management Board
13 February 2008



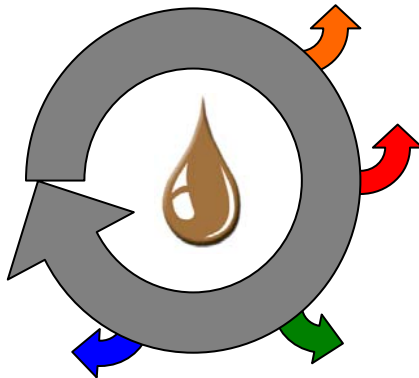
Dr. Adam H. Love, Mackenzie R. Johnson, Dr. John G. Reynolds

Project Objectives

Original Task:

Determine feasibility for re-refining used oil through existing facilities

- Technical requirements
- Non-technical requirements
- Analysis



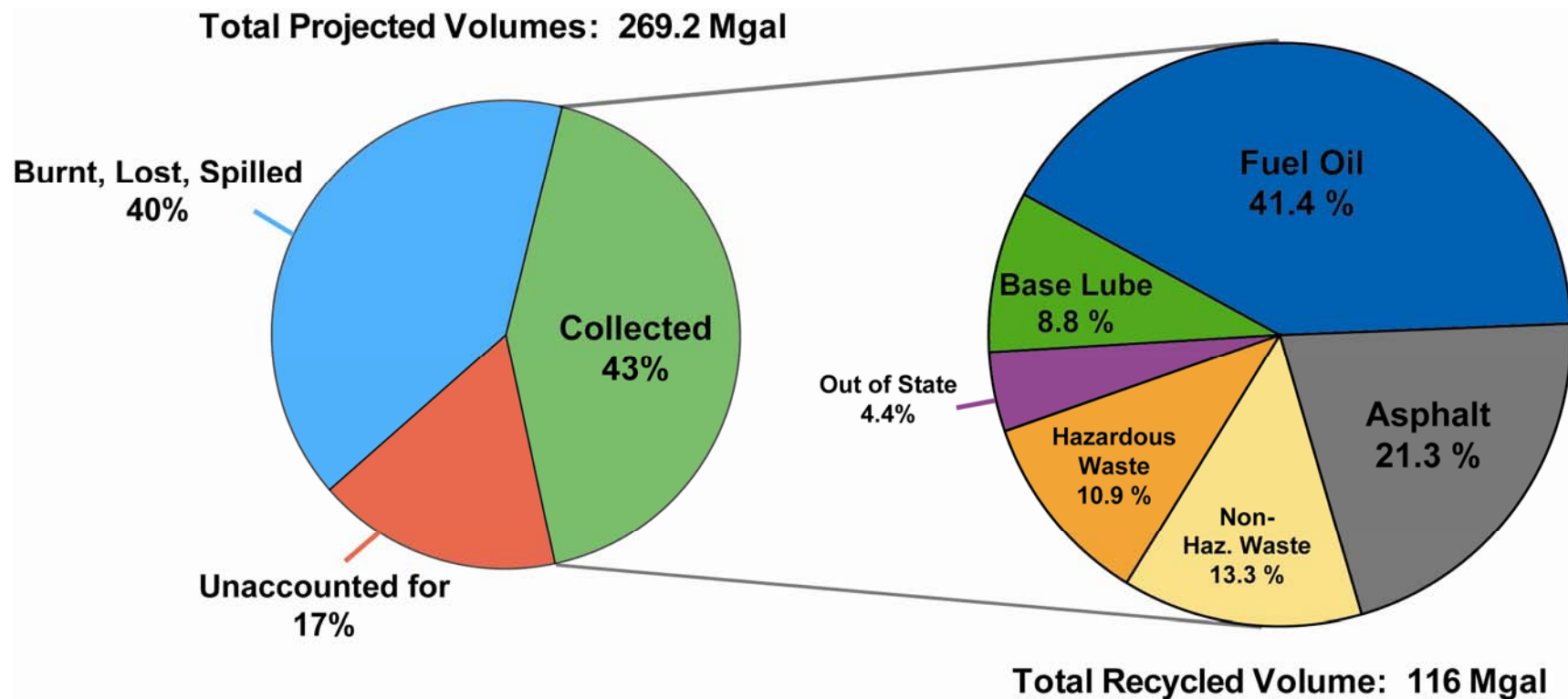
Revised Task:

Perform system analysis of used oil market and evaluate potential changes that would promote “highest and best use” of recycled oil products

- Used oil system description
- Used oil system forces
- Recommended system changes

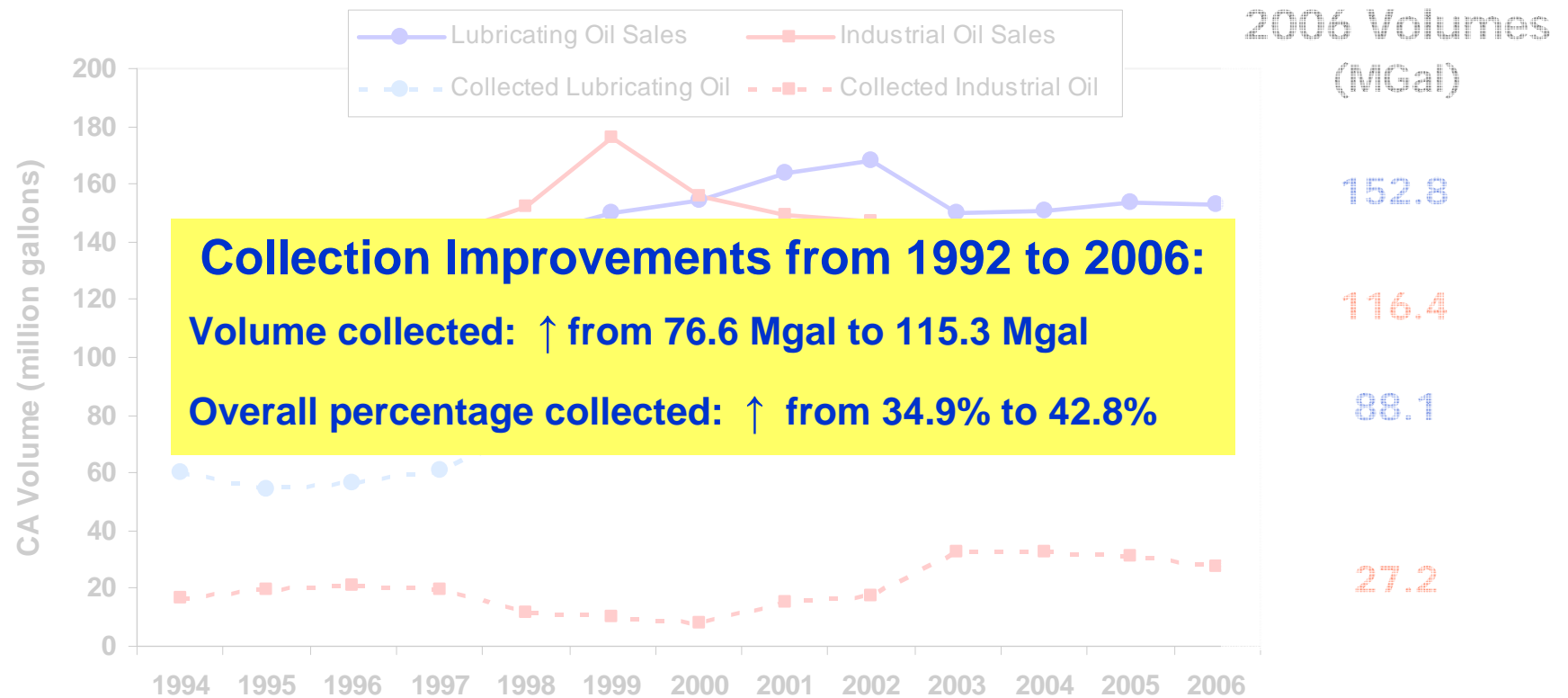
2006 Used Oil Market

Data from CIWMB (2007)



**Most of the used oil collected
currently gets reused**

Used Oil Collection Trends



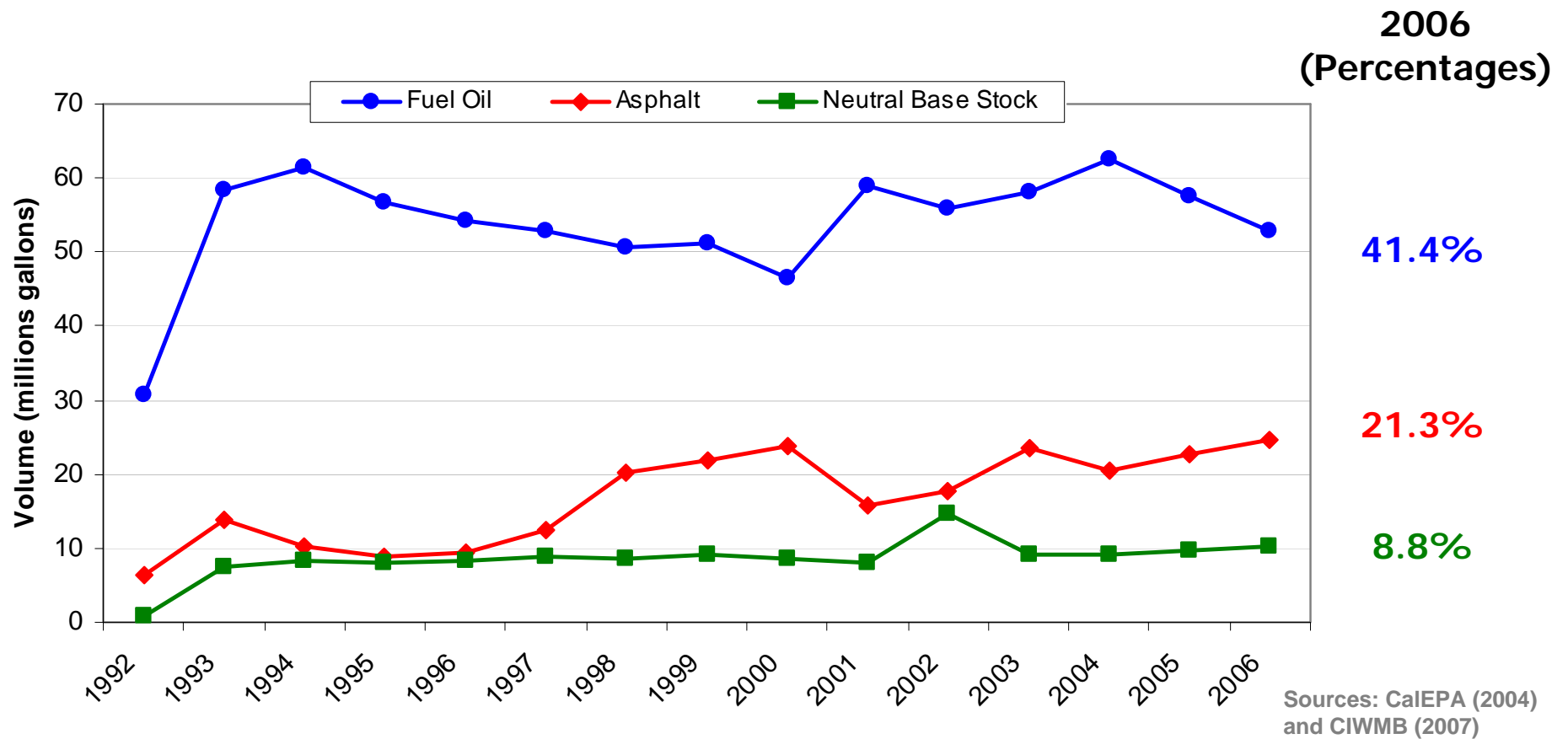
Data from CIWMB (2006, 2007)

- Successfully met the “Instrumental Objective” of the CORE Act
- “Good progress” towards meeting the “Program Objective”
- Not meeting “Legislative Goal” toward resource conservation

(CalPoly, 2005)



Used Oil Product Trends



Used Oil Recycling to Base Stock has remained relatively constant



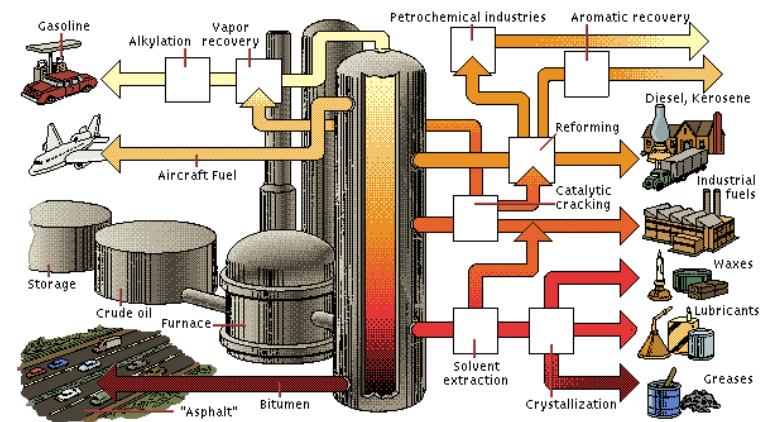
Original Task: Using existing refineries

Assumption:

Current rerefining capacity limits the amount of oil rerefined in CA, therefore increasing capacity would increase production

Initial Results:

1. CA's only current rerefiner limited primarily by availability of used oil
2. CA hazardous waste designation for used oil is a barrier to rerefining
3. Existing refineries have little motivation to accept used oil

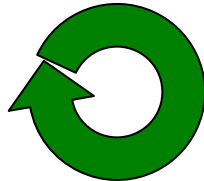


Rapidly concluded that rerefining capacity was *not* limited by technical feasibility, but by dynamics of current used oil market system

Revised Task: Optimize “highest and best use”

Closed-loop Recycling

- Product equal or exceeds quality of original material
- Repeatable cycle

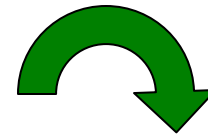


For recycled used oil:

- Not all used oil can be closed-loop recycled
- Recycled lube oil is not 100% closed-loop

Downcycling

- Product of lower quality than original material
- Finite reuse



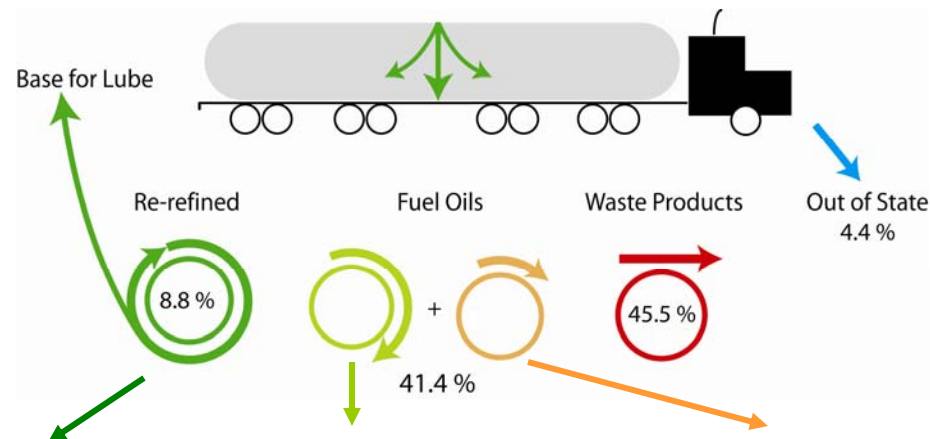
For downcycled used oil:

- Not all used oil can even be downcycled
- Not all downcycling products are equivalent

CIWMB defined “highest and best” use as closed-loop recycling



Recycling Products/Processes in California



Rerefined Base Lube

- Dehydration/ Filtration
- Distillation
- Hydrotreatment

- Closed loop - 75% recovered
- Lowest heavy metal and Sulfur concentrations
- Asphalts removed

Marine Distillate Oil

- Dehydration/ Filtration
- Distillation

- Downcycling
- Low heavy metal and Sulfur concentration
- Asphalts removed

Recycled Fuel Oil

- Dehydration/ Filtration

- Severe Downcycling
- Minimal removal of heavy metals and Sulfur
- Least desirable

Rerefined base lube is energy and resource conservative compared with virgin product
(Boughton and Horvath, 2004; GEIR, 2005; DOE, 2006)

Used Oil Sources

Automotive Oils:



- Generally cleaner than industrial oils
- Heavy metals from additive packages, engine wear
- Can often be closed-loop recycled, if not contaminated

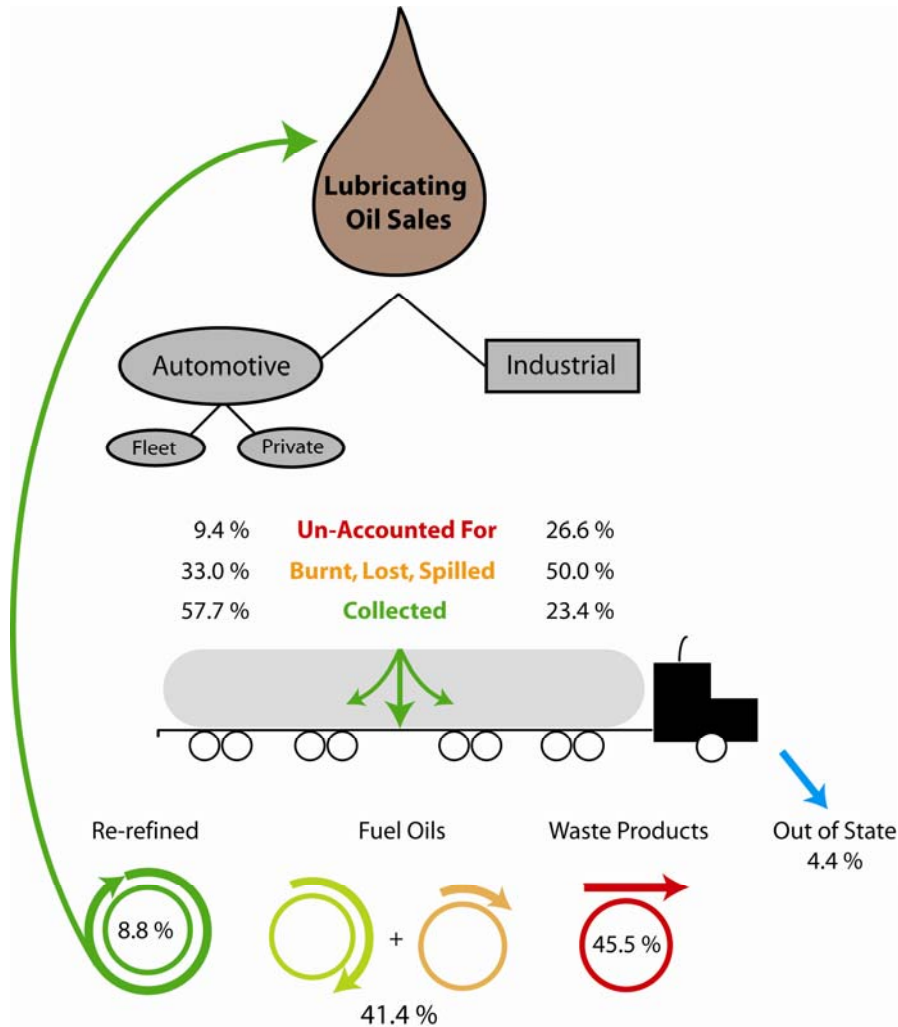
Industrial Oils:



- Generally dirtier than automobile oils
- Heavy metals, solvents, sediments accumulate from machinery during use
- Difficult to closed-loop recycle

Often times these two sources are mixed during hauling or upon receipt – reducing the value of the used automotive oil for re-refining

Overall Lube Oil System



Numerous stakeholders within the used oil system.

Generators

Collectors

Haulers

Recyclers

Current Used Oil Recycling Incentive

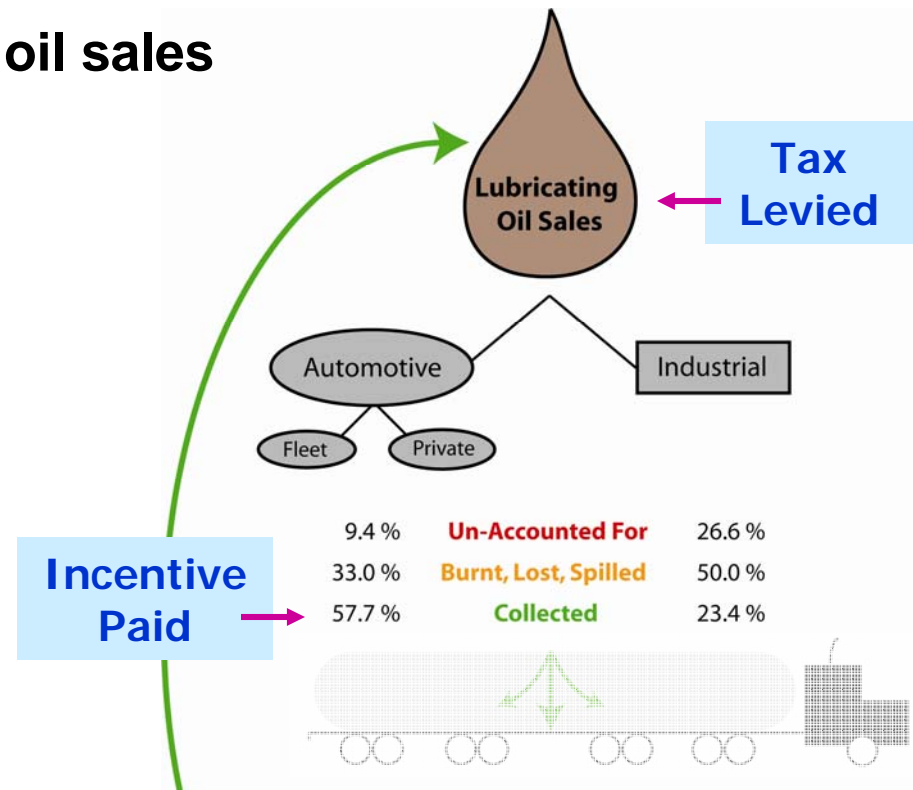
- \$ 0.16/ gallon collected from oil sales

- \$ 0.16/ gallon incentive for collection center

- Incentive not large enough to encourage DIY participation
SFSU (2002)
- Most claims stay with CCC
CalPoly (2005)

- Stakeholder interviews:

- Incentive not a significant revenue source (< 1% Income)
- Incentive does not cover cost of hauling



Collection Center incentive focuses on improving collection from generators, not closed-loop recycling

Optimizing “Highest and Best Use”

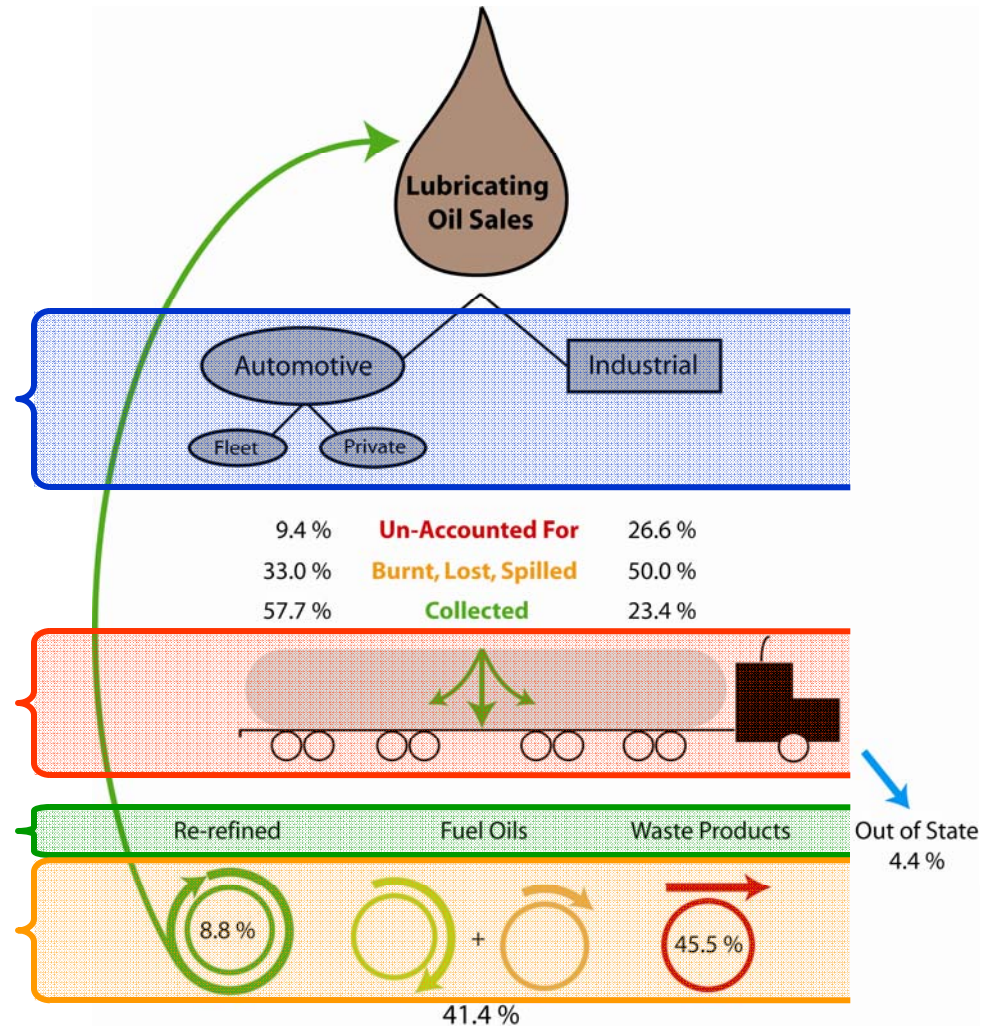
Numerous mechanisms that can affect change and encourage recycling to base oil

1. Maintain Sorting

2. Encourage Hauler

3. Create Product Demand

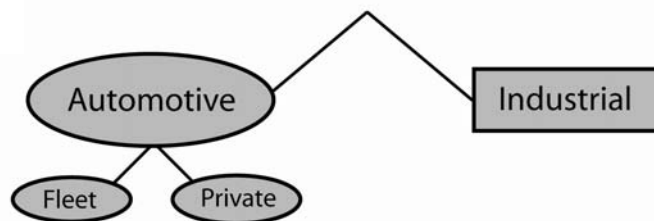
4. Incentivize a Process



Options 1 & 2: Increase Quality of Used Oil

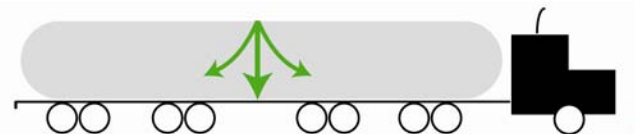
Maintain Sorting

- **Advantage**
 - Increases volume of potentially re-refineable used oil
- **Feasibility**
 - Current business model in practice which hauls industrial and automotive oil separately
- **Implementation:**
 - Increase in storage and transportation costs



Encourage Hauler

- **Advantages**
 - Rewards haulers that maintains segregated source streams
 - Subsidizes associated increase in hauling costs
- **Feasibility**
 - Modification of collection incentive program
- **Implementation**
 - Shift incentive to hauler
 - Subsidizes hauling costs



Option 3 & 4: Encourage Recycling to Base Oil

Create Product Demand

- **Advantages:**
 - Promotes rerefining with market drivers
- **Implementation:**
 - Mandatory recycled content
 - Mandatory use
 - Tiered rebate proportional to recycled content
- **Precedent:**
 - Italy mandates recycled content
(DOE, 2006)
 - State of California/US Federal Gov't mandate use
- **Market considerations:**
 - Cost burden placed on market
 - Complexity of rebate implementation

Incentivize a Process

- **Advantages:**
 - Promotes rerefining with subsidized costs
- **Implementation:**
 - Subsidy for processes that lead to “highest and best use”
- **Precedent:**
 - Australia has tiered benefit program:
 - \$0.50/ liter for re-refined
 - \$0.03-0.07/ liter for diesel, diesel extenders, industrial heating oils
 - \$0.00/ liter for reprocessed or filtered, but not re-refined (DEWR, 2007)
- **Market Considerations:**
 - Subsidy burden placed on taxpayers
 - Industry dependence on subsidy



Stakeholder Concerns



Modifying Current System Dynamics

- **Collectors/Storage**
 - Maintaining sorting could add costs
 - Changing current incentive would cause some to drop out of the program
- **Haulers**
 - Increased paperwork
 - Logistics difficulty
 - Increased hauling costs
- **Recyclers**
 - Current business models are tuned to current system dynamics
 - Increased hauling costs
 - Favoring specific technologies
 - Does not optimize “highest and best production” for the entire used oil system



Externalities: Non-system Factors

- **CA Air quality regulations**
 - Establishing or expanding facility operations becomes increasingly difficult
(Gary Colbert, per.comm.; Jim Ennis, per.comm.)
- **EPA Marine Emission Standards**
 - New tier established by December 2009 (EPA, 2007)
- **More stringent API Standards for lube oils**
 - Require greater degree of processing for certification as lube oil
- **CalEPA Hazardous waste categorization of used oil**
 - Allows out-of-state recycling facilities to out-compete for California's best used oil sources

**The used oil system is, and will continue to be,
significantly impacted by the changing demands of
driving forces outside the market system**



Preliminary Recommendations

Optimal Approach:

A combination of these two options

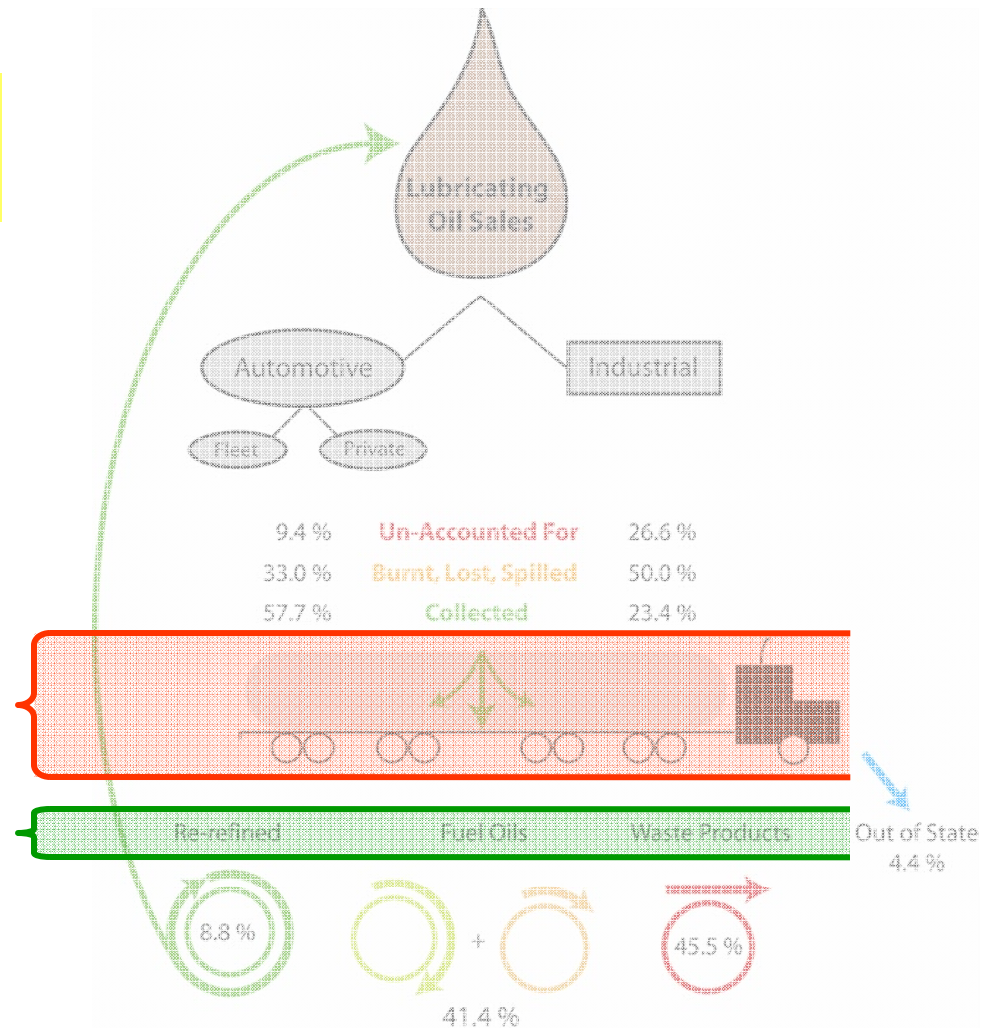
Shift Incentive to Hauler

(comparable to implementation of Electronic Waste Recycling Act of 2003 [PRC 42460])

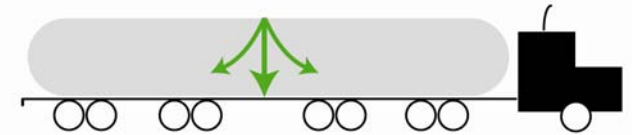
Previously implemented in Germany (API, 1997)

Mandatory Recycled Content

(comparable to PRC 42760 for recycled content of newsprint)



Potential Stakeholder Impacts

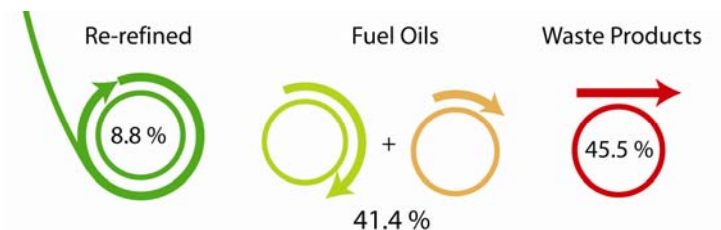


■ Shift Incentive to Hauler

- \$0.16/gallon for used oil delivered to a certified facility and accepted for rerefining to base lube oil
- Increased reporting burden on hauler
- Intended to reduce or eliminate hauling costs for CCC with quality suitable for recycling to base lube oil

■ Mandatory Recycled Content

- Regulatory Change
- Encourages technology development
- Industry concerns with free market interference



Acknowledgements

**** Numerous CCC's and Haulers**



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CIWMB

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DeMenno/Kerdoon

"Recycling For A Cleaner Environment"

**N. Bonnie Booth
Jim Ennis**

**Dept. Toxic Substances Control
Bob Boughton
Charles Corcoran
Reports Library**



Evergreen
Evergreen Oil, Inc.

**Gary Colbert
Bob Sulnick**



INDUSTRIAL SERVICE
OIL COMPANY, INCORPORATED

(Pete Kotoff)



**Christopher Harris
Numerous members**



**Bill Briggs
Charles Johnston
Ame LeCocq**

Pacific Operators Offshore, Inc.

